Usage Guide For Vibrometry Research

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1 Introduction

This document is intended for use by the University of Bristol UNDT Group as a follow up to the 'Video Vibrometry for use in Non-Destructive Testing' by allowing the researcher to quickly replicate results in said document.

2 Procedure for Replicating Results

2.1 Acquiring Videos

- Ensure that the FLIR Blackfly S is connected to a USB 3.0 port via a USB 3.1 Micro-B connector. If using a trigger, the BNC end of the Hirose connection should be connected to the generator in output mode with the desired signal. Spinnaker/SpinView should be installed on the PC to make use of the Blackfly S.
- Open SpinView. If the drivers are properly installed (which is usually the case after installation), then the camera's model should appear in the Devices window. Click on it to access its parameter options.
- Another window should open after clicking the device, possibly showing the video currently being acquired by the camera. This window and the device window feature 'play' and 'stop' buttons which control acquisition to the output window.
- To alter a vast majority of the capture parameters, image acquisition must be stopped. Though the Stop button works for most applications, the 'Acquisition Stop' button at the top of the device features tab is sometimes necessary to terminate background processing. Clicking it is recommended if a control is locked despite the source window showing no acquisition.
- The parameter window has a series of tabs at its bottom allowing for control of the different modes of operation. For the most part, only the 'Features' and 'Image Format' tabs will be used, mainly because the contents of the other tabs are also included in Features.
- The camera should have parameter presets available by navigating to the 'User Set Control' header and loading the relevant parameter set.
  - Default resets the parameters to their original value(s)

- Set 0 was intended for manual capture with a fixed, user definable frame rate and frame exposure time. The 'Image Format' tab should also show that the Region of Interest is centred in the camera's CCD capture zone.
- Set 1 is intended to be the 'trigger capture' preset, as the acquisition is controlled by external trigger and exposure time is dependent on the delay between the signals' rising edges.

- If the presets do not exist, then the controls in the 'Features' tab must be defined manually.
  - For a fixed capture mode, the most important settings are to have Acquisition Mode on Continuous, Trigger Mode to be Off, and Exposure Auto Off. Having manual exposure times allows for greater freedom when setting the Acquisition Frame Rate (which must also have its relevant tickbox checked.) Reading the tooltips which appear at the bottom of the window when a control is selected will often provide additional advice.
  - If camera capture rate is to be controlled by the signal generator, MultiFrame is recommended for the Acquisition Mode. Since NDT applications are often well controlled, the intended duration (or frame count) for capture is often known. Using MultiFrame with a few more frames (in 'Acquisition Frame Count') than what is intended is useful because Continuous forces the camera to continue grabbing images beyond the demanded number (although the number of saved images is the same), and places unnecessary computational burden. It is recommended to press the Stop Acquisition button when in this mode after capture, even if the window doesn't show a moving image.

    Beyond that, Exposure Mode is free (although Timed duration has to be less than the period of capture), although keeping automatic exposure off is recommended to achieve consistent results as well as maintain high frame rates. Square waves operating between 0 and 5V have been tested; the camera reliably captures at frequencies up to 190Hz. Since the signal is only used to produce a Frame Start command, altering the duty cycle of the wave does not alter the exposure time.

    Setting up the trigger properly: Trigger Selector on Frame Start, Trigger Mode On, Trigger Source on Line 0 and Trigger Activation set to Rising Edge.
  - In both cases, the movie capture size may be altered. Since there is a visual representation of where the computer will read the camera's CMOS chip, the Image Format tab is recommended when setting capture dimensions. The author prefers to capture around 600px x 600px as there is a trade off between image size and maximum acquisition rate without dropping frames. The 600px square will comfortably capture 150fps, and can possibly be pushed further.

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- With SpinView parameters set, the acquisition proper may be performed. Pressing the large red circle icon in the preview window brings up the recording menu. This menu allows the target output location and name (appended by a long timestamp) to be set, the duration or number of frames to capture, and the file format to output. An important detail to note is that triggered image capture only supports individual image saving instead of a direct AVI output; recording a video will simply use a fixed playback framerate. Another confusing matter is that the true rate of *image acquisition* from the camera is the value in the Features menu, while the Frame Rate specified in the Recording

Window seems to be the metadata and playback frame rate. It is highly advised to check that both values match before recording, or click the "Use Camera Frame Rate" after setting it in Features.

- Playback the video to ensure everything is as expected. If triggered capture was used, the individual images must be matched into a single video file. The author recommends using VirtualDub, an open-source video dubbing tool which is capable of rapidly matching images into a single video. To ensure that it reads all images properly, highlight all of the frames in the folder, rename the first to something recognisable (e.g. `30Hz_10V_150FPS`), and confirm. This should append the entire selection with a bracket pair from 1 to the final frame. (e.g. `30Hz_10V_150FPS (342)`). VirtualDub can now read the entire video by selecting a frame, and therefore allows it to export a single AVI file to be processed by MATLAB.

2.2 Processing in MATLAB

This section details the variables which may be altered in the code as opposed to how the inner workings of the code work (which may be found by navigating to the relevant section for each function/script). With the video files acquired, the `video_processor_parent` code will run provided that the video's directory is specified in line 7 as `original_fname`. By default, the code will analyse the entire video space, although redefining the vectors `x_range` and `y_range` will crop the region of interest. `frame_range` and `spatial_downsample` are also user defined discrete values. They tell MATLAB the indices of the start and end frames for analysis and if the video's resolution needs to be artificially worsened respectively.
Since the code uses a kernel which analyses the elements within, and is translated around the image, the size of the kernel and its translation step size may be altered. Notably, making the kernel size too small will return singular matrices in regions of video with little activity. While not a major concern in isolation, the knock-on effects can cause the code to fail altogether. Therefore, it is recommended to increase the kernel size if this is the case. The step size is defined by dividing the kernel dimensions by an integer and rounding it. This maintains the ratio of step size to kernel size, but if it is preferred to work with arrays of the same size while altering the kernel, use of a constant is preferred.
There are a few logical `options` parameters available. They allow the code to redefine the co-ordinate axes to lie along the directions of greatest movement (`force_to_dominant_image_feature_direction`) or to choose between displacement and velocity.

3 Procedure for Replicating Results

Disclaimer: Intended to help with following-up the research in this report.

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